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UTILITY OF CAUDAL FIN RAY COUNTS IN CLASSIFICATION OF SUPRAGENERIC CATEGORIES OF INDIAN SILUROID FISHES

RANI SINGH AND K. C. JAYARAM
Zoological Survey of India, Calcutta

ABSTRACT

The practice of routine counting of branched and unbranched rays of paired and unpaired fins, in fishes have been in vogue since many years. However, in recent years plotting these counts as frequency distribution polygons have yielded a better picture in interpreting the systematic affinities and ultimately the phylogeny of the families themselves. The caudal fin in most genera of catfishes (Order Siluriformes) is forked and the number of principal unbranched rays are usually one on each lobe. An examination of a large series of material of many Indian genera and species have revealed an interesting pattern. It is seen that most families have constantly seven branched rays in the upper lobe of the caudal fin and eight in the lower lobe.

INTRODUCTION

Order Siluriformes comprises thirteen families, 48 genera and about 160 species from India, Pakistan, Bangladesh, Burma and Sri Lanka. Most of them are confined to fresh water except Ariidae and Plotosidae which occur in the sea and brackish water. Many workers have studied the morphology and osteology of catfishes (Bamford, 1948 ; Bhimachar, 1932, '33 ; Chranilov, 1929 ; David, 1935 ; Eaton, 1948 ; Gauba, 1962, '66, '67 ; '70 ; Jayaram, 1955, '70 ; Joseph, 1960 ; Kindred, 1919 ; Karandikar and Masurekar, 1954 ; Lenous, 1968 ; McMurrich, 1884 ; Masurekar, 1962 ; Nair, 1938 ; Nawar, 1954 ; Reichel, 1927 ; Shelden, 1937 ; Srinivasachar, 1957, '58, '59, '80 and Tilak, 1961, '63,'64, '67). However, not much attention seems to have been paid towards the utility of caudal fin ray count as a possible taxonomic tool.

In recent years, this character has come into prominence for tracing intergeneric and family affinities. Notably many American Ichthyologists have adopted this character profitably. Ginsburg (1945) was the first to demonstrate the utility of different kinds of caudal fin rays in classical taxonomy. Gosline (1961) considered only the branched rays in Cyprinoid fishes and indicate that the round tailed members have the lowest (and apparently the most variable) number of branched caudal fin rays.

Generally, the caudal fin of most Indian genera of siluroid families such as Bagridae (except genus *Pseudobagrus*), Pangasidae, Ariidae, Schilbeidae, Amblycepidae, Sisoridae (except genus *Euchiloglanis*, *Glyptosternum*, *Coraglanis*, *Oreoglanis* and *Pseudecheneis*) and Siluridae (except *Silurus*) is forked. In other families Olyridae, Plotosidae, Chacidae Clarii-

dae, Heteropneustidae and in genera *Silurus* (Siluridae), *Euchiloglanis*, *Glyptosternum*, *Coraglanis*, *Oreoglanis* and *Pseudecheneis* (Sisoridae) and in *Pseudobagrus* (Bagridae), the caudal fin is truncate, rounded or emarginate.

Material

We have examined the representatives of almost all families of Indian Siluroids excepting Akysidae, 402 specimens falling under 12 families 28 genera and 60 species were studied. Wherever possible fresh specimens were collected and examined. The preserved specimens in the National Zoological Collections present in the Zoological Survey of India, Calcutta were also examined. Skeletal preparations of the entire caudal vertebral complex besides Alizarine transparencies were made. The different kinds of caudal fin rays enumerated in this study are segmented branched rays, segmented unbranched rays, and unsegmented unbranched rays (=simple rays).

The counts were made on both sides of the caudal fin under a stereoscopic Binocular microscope and the data recorded. In the case of unique specimens, or difficult to obtain species, counts were obtained from X-ray photographs.

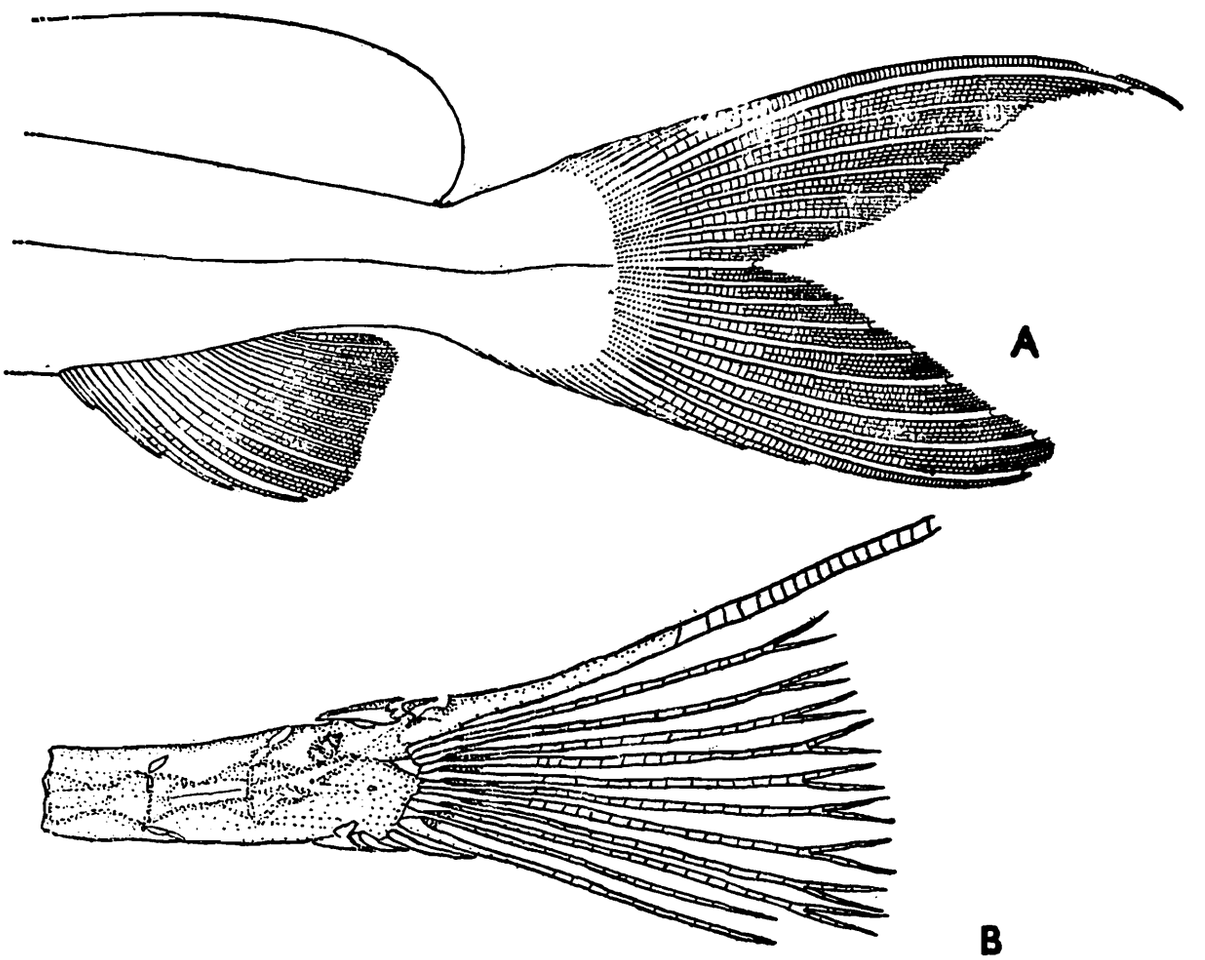

Fig. 1. A. Caudal fin of *Auchinoglanis biscutatus* showing 7+8 segmented branched rays. B. Caudal fin of *Sisor rhabdophorus* showing 4+5 segmented branched rays.

RESULTS

Table I presents the general pattern in the material examined. Out of 12 families of Siluroids examined six families (*i.e.*, Amblycepidae, Bagridae, Pangasidae, Schilbeidae, Siluridae and Sisoridae) have 15 segmented branched rays arranged in one pattern, *i.e.*, 7 rays in upper half and 8 in the lower half of caudal fin (see fig. 1 A). This frequency is constant and is not seen varying even up to family level. The second group of the families (Olyridae, Clariidae, Heteropneustidae and Ariidae) have 11 to 14 segmented branched rays in the caudal fin ; but unlike the earlier group the number of rays in the upper and lower half are in three different patterns. Family Olyridae has 5+6 (fig.2A) ; Clariidae and Heteropneustidae 7+7 (fig. 2C) and Ariidae 6+7 (fig. 2 B) in the upper and lower half respectively. In Plotosidae and Chacidae there is no demarcation of the upper and lower half and all the caudal fin rays originate from a single hypural plate (see fig. 3). As such the total number of branched rays are 9 to 10 in Plotosidae and 10 to 11 in Chacidae.

It may be stated here that some abberations which appear to be extremely rare and isolated are also seen. Out of 26 specimens of *Clarias batrachus* (Clariidae), three specimens (101 mm, 169 mm and 210 mm in standard length) were found to have 6 instead of 7 branched rays in the lower half of the fin. Similarly, among 16 specimens of *H.*

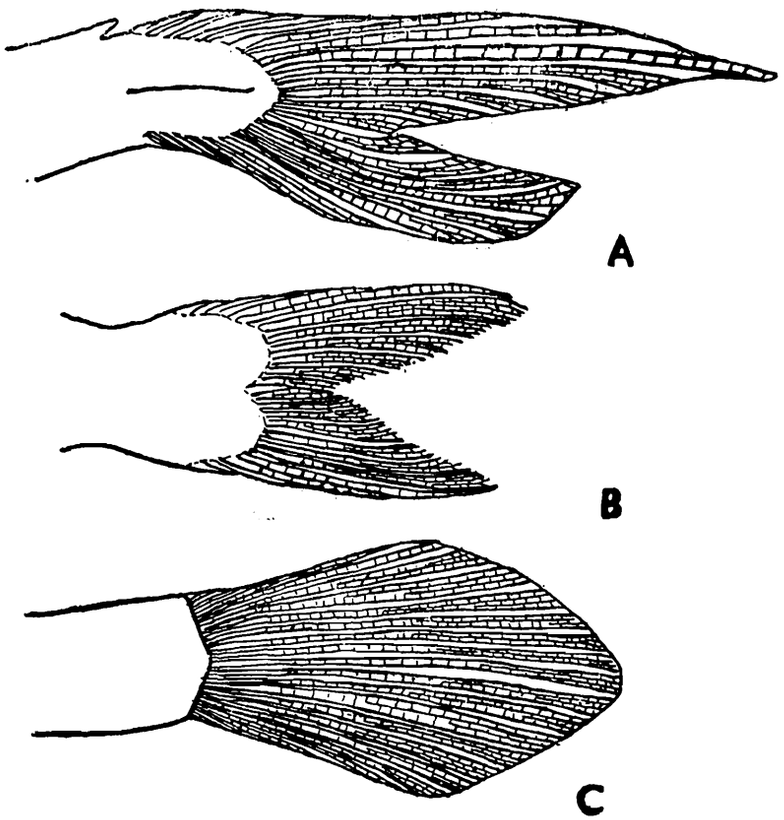

Fig. 2. A. Caudal fin of *Olyra longicaudata* showing 5+6 segmented branched rays. B. Caudal fin of *Tachysurus dussumieri* showing 6+7 segmented branched rays. C. Caudal fin of *Clarias batrachus*, showing 7+7 segmented branched rays.

fossilis (Heteropneustidae), one specimen (150 mm in SL) was found to have 6 branched rays in upper and 6 in lower half instead of 7 branched rays in both the half. The sisorid genus *Euchiloglanis* generally has 7+8 branched rays in the upper and the lower half of the caudal fin but we have observed 7+7 in one specimen of *E. kamengansis* (52 mm in SL). Six specimens of *Eutropiichthys vacha* (Schilbeidae) examined, one specimen(70 mm in SL) was found to have six segmented branched rays in upper as well as lower half of caudal fin instead of 7 and 8 rays respectively.

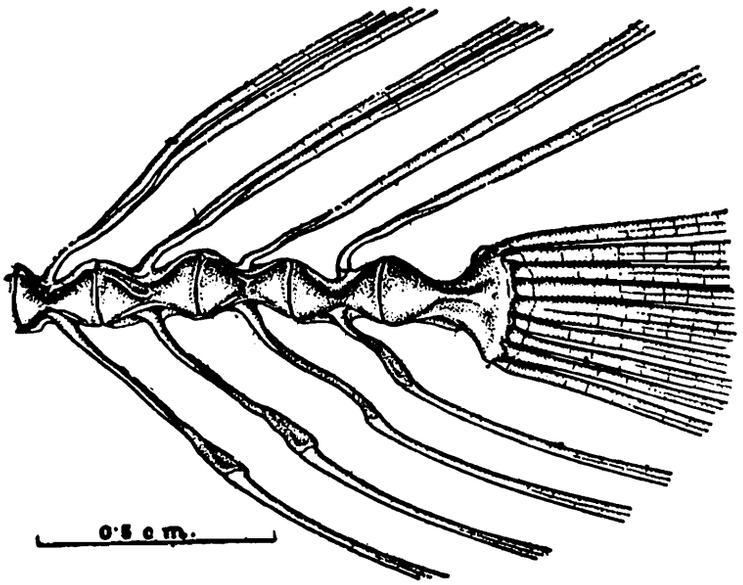

Fig. 3. Caudal fin of *Plotosus lineatus* with some vertebrae showing segmented branched rays.

Genus *Sisor* presents some interesting results. The upper half of the caudal fin has one segmented unbranched ray and four segmented branched rays ; the lower half has two segmented unbranched and five segmented branched rays (see fig. 1 B). The occurrance of nine segmented branched rays in total in the caudal fin of this genus *versus* 15 in all other genera is an interesting findings. Considering the fact that the adipose fin is also modified in the form of a spine and the caudal penduncle is narrow like a whip only in this genus as compared to all other Indian Siluroids, the presence of only fewer segmented branched rays is significant. It would seem that *Sisor* represents a separate phyletic line from the other sisorids and alone perhaps have to be segregated as a separate family.

Discussion

The analyses of the above frequency distribution of caudal fin ray counts (see Table II) indicate that the Siluroid genera examined by us can be grouped into five groups, based on the number of segemented branched rays. The first group of six families, Bagridae and five other mentioned earlier has 15 (7+8) branched rays in the caudal fin except genus *Sisor* which comprises only 9 branched rays.

Clariidae with Heteropneustidae as second member has 14 (7+7) branched rays ; Ariidae,

TABLE—I Frequency distribution of different kinds of caudal fin rays in Indian Siluroid fishes

Family, genera and species	No. of examples	Range of SL in mm	Total number of segmented branched rays in upper & lower half	Total number of segmented unbranched rays in upper and lower half	Total number of unsegmented unbranched rays in upper & lower half
PLOTOSIDAE					
Plotosus					
P. lineatus	9	92-288	9-10	—	—
P. canius	8	74-297	9-10	—	—
CHACIDAE					
Chaca					
C. chaca	12	81-150	10-11	*21-23	—
ARIIDAE					
Tachysurus					
T. arius	18	107.50-345	6+7	2-4+3-4	11-18+11-18
T. maculatus	9	112-315	6+7	3+3-4	13-19+11-19
T. jella	4	130-225	6+7	3+3-4	13-15+11-13
T. gagora	12	198-250	6+7	2-3+3-4	11-15+13-17
T. thalassinus	10	116-610	6+7	2-3+3-4	15-16+12-16
T. caelatus	18	45-190	6+7	2-3+3-4	14-17+15-16
T. dussumieri	20	110-385	6+7	2-4+3-4	13-16+12-16
T. sona	6	95-325	6+7	3+3-4	11-17+11-16
T. sagor	4	145-250	6+7	2-3+3-4	12-15+12-17
T. subrostratus	10	110-285	6+7	4+4-5	11-13+10-12
T. crossocheilus	5	170-245	6+7	3+3-4	17-20+17-20
Osteogeneiosus					
O. militaris	14	75-365	6+7	2+3	12-18+11-16
Batrachocephalus					
B. mino	1	223	6+7	4+5	11+12
CLARIIDAE					
Clarias					
C. batrachus	26	66.5-229.0	7+6**-7	1-3+1-3	2-4+2-4
HETEROPNEUSTIDAE					
Heteropneustes					
H. fossilis	16	91-225	6**-7+6**-7	1-4+1-2	3-9+1-5
H. microps	1	98.5	7+7	4+2	4+1
BAGRIDAE					
Rita					
R. rita	15	41.5-235.0	7+8	2-4+2-5	12-15+12-16
R. kuturnee	3	143-179	7+8	2+2-4	16-17+11-15

The number with * marks represents the dorsal procurrent part of caudal fin.

Table 1 (contd.)

Family, genera and species	No. of examples	Range of SL in mm	Total number of segmented branched rays in upper & lower half	Total number of segmented unbranched rays in upper and lower half	Total number of unsegmented unbranched rays in upper & lower half
Horabagrus					
H. brachysoma	5	96-137	7+8	2+2-3	10-15+8-14
Mystus					
M. gulio	7	47-106	7+8	2+2-3	12-15+8-14
M. cavasius	5	68-108	7+8	2+2	7+7-8
Aorichthys					
A. aor	5	130-193	7+8	2+2-3	8-10+6-8
SISORIDAE					
Glyptothorax					
G. pectinopterus	14	51-143	7+8	1-2+1-2	6-3+6-12
G. punjabensis	5	42-106	7+8	3+2	2+4
Glyptosternum					
G. reticulatum	4	57-117.5	7+8	2+3	8+8
Euchiloglanis					
E. feae	4	50-110	7+8	2+2	4-7+5-7
E. kamengansis	6	52-115	7+7**8	2+2	5-8+5-8
E. hodgarti	3	85-115	7+8	2+2	5-7+5
Gagata					
G. cenia	10	45-55	7+8	3+3-4	10-12+10-13
G. gagata	2	110-121	7+8	4+5	13-15+12
Nangra					
N. nangra	4	46.5-75	7+8	3+4-5	11-14+13
N. viridescens	2	47-60	7+8	3-4+4-5	12-13+11-14
Pseudecheneis					
P. sulcatus	4	105-128	7+8	2-3+2-3	6-7+5-8
Bagarius					
B. bagarius	4	95.5-141	7+8	2+2-3	8+9-13
Sisor					
S. rhabdophorus	4	78-150	4+5	1+2	1+1
SILURIDAE					
Wallago					
W. attu	8	135-481	7+8	1-2+1-2	2-5+2-3
Ompok					
O. bimaculatus	4	115-207	7+8	1-2+1-2	2-3+1-2
O. pabo	2	106-199	7+8	1+2	2-3+2
Silurus					
S. gangetica	7	75-106	7+8	2+3	14-18+14-15

Table 1 (contd.)

Family, genera and species	No. of examples	Range of SL in mm	Total number of segmented branched rays in upper & lower half	Total number of segmented unbranched rays in upper and lower half	Total number of unsegmented unbranched rays in upper & lower half
PANGASIDAE					
Pangasius					
P. pangasius	24	41-170	7+8	2-3+2-4	12-20+10-16
SCHILBEIDAE					
Clupisoma					
C. garua	10	75-129	7+8	2-3+3-4	6-13+5-13
Eutropiichthys					
E. vacha	6	70-105	6**-7+6**-8	3+4	7-13+7-13
Ailia					
A. coila	5	58-81	7+8	3-5+3-4	10-13+13-14
A. punctata	9	69-136	7+8	3-4+2-5	5-16+8-12
Silonia					
S. silondia	8	55-80	7+8	2-3+2-4	13-17+7-13
AMBLYCEPIDAE					
Amblyceps					
A. mangois	18	36-105	7+8	3-6+3-5	9-16+6-13
OLYRIDAE					
Olyra					
O. longicaudata	10	46-90	5+6	3-4+2-3	5-2+6-10

the sole member of the third group has 13 (6+7) branched rays and Olyridae with 11 (5+6) branched rays. The Plotosidae and Chacidae form a separate group with 9-11 branched rays as a single unit.

For a number of years, Regan's (1911) proposition that the Bagridae formed a basic line of evolution of other siluroid families has been accepted. Gosline (1944) considered the evolution of different siluroid families not from a single phyletic line but from several branches. Recent researches such as those of Chardon, 1968 ; Srinivasacher 1980 ; show that there are divergent phyletic groups in Siluroids. Our studies indicate five different

TABLE II—Frequency distribution of segmented branched rays of caudal fin in Siluriformes

	9	10	11	12	13	14	15
PLOTOSIDAE (19)	—	—					
CHACIDAE (12)		—	—				
OLYRIDAE (10)			—				
ARIIDAE (130)					—		
CLARIIDAE (26)						—	
HETEROPNEUSTIDAE (17)						—	
BAGRIDAE (40)							—
SISORIDAE (66)	—						—
SILURIDAE (19)							—
PANGASIDAE (24)							—
SCHILBEIDAE (38)							—
AMBLYCEPIDAE (18)							—

Number in paranthesis after each family indicate the number of specimens examined.

The number with ** marks represents aberrant number.

groupings of the families based on the frequency distribution of the branched rays (see Table II). Of these the family Bagridae appears to have the largest number of allied families compared to Plotosidae or Clariidae. It is also evident that Plotosidae and Ariidae have separate lineages unlike Bagridae. Whether the five trends exhibited by the fin rays reflect the phylogeny or not is debatable but would definitely be indicative. Further work on osteological and myological evidences are being carried out by the authors which may help to adduce definite conclusions.

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REFERENCES

BAMFORD, T. W. 1948. The cranial development of *Galeichthys felis*. *Proc. zool. Soc. Lond.*, **118** (2) : 364-391.

BHIMACHAR, B. S. 1932. The siluroid skull. *Curr. Sci.*, **1** : 70-71.

——, 1933. On the morphology of the skull of certain Indian Catfishes. *Half-yrly. J. Mysore Univ.*, **7** : 233-267.

BRIDGE, T. W. AND HADDON, A. C., 1893. Contribution to the anatomy of Weberian ossicles in the siluroid fishes. *Phil. Trans. Roy. Soc.* Lond., (B) **84** : 65-333.

CHARDON, M. 1968. Anatomie comparee de l'appareil de Weber et des structures connexes chez les Siluriformes. *Musee Royal de L'afrigue Serie* In—8°-*Sciences Zoologiques*—n°169 : 1-125.

CHRANILOV, N. S. 1929. Beitrage zur kenntnis das Weberschen Apparates der Ostariophysi. 2. Der Weber'schen Apparates bei Siluroidea. *Zool. Jb. Anat.*, **51** : 323-462.

DAVID, L., 1935. Die Entwicklung der Clariiden und ihre verbreitung. Eine anatomisch-systematische Untersuchung. *Revue Zool. Bot. afr.*, **28** (1) : 77-147.

EATON, T. H. 1948. Form and function in the head of the channel catfish (*Ictalurus lacustris punctatus*). *J. Morph.*, **83** : 181-194.

GAUBA, R. K. 1962. The endoskeleton of *Bagarius bagarius* (Ham.). Part I. *Agra Univ. J. Res.* (Sci.), **11** : 75-90.

——. 1966. Studies on the osteology of Indian sisorid catfishes. II. The skull of *Glyptothorax cavia*. *Copeia* : 802-810, 5 figs.

——. 1967. Studies on the skull of the Indian sisorid catfish, *Erethistes pussilus*. *J. Zool., Lond.*, **151** : 379-388, 16 figs.

——. 1970a. The osteology of family Chacidae. 1. The skull of *Chaca chaca* (Hamilton). *Monitore zool. ital.*, **4** (1) : 21-40, 5 figs.

——. 1970b. Contribution on the skull of a catfish, *Erethistoides montana* Hora. *Zool. Beitr.*, **15** : 181-201.

——. 1970c. On the cranial osteology of two Indian catfishes of the genus *Laguvia*. *Zool. Anz.*, **185** : 55-67, 5 figs.

GINSBURG, I. 1945. Contribution to a methodology in the caudal fin ray count of fishes and its use in classification. *Copeia*, : 133-142.

GOSLINE, W. A. 1944. The problem of the derivation of the south American and African freshwater fish faunas. *Anais Acad. bras. Cienc.*, **16** : 211-223.

GOSLINE, W. A. 1961. Some osteological features of modern lower teleostean fishes. *Smithson. misc. Colln.*, **142** (3) : 1-42, 6 figs.

JAYARAM, K. C. 1955. Taxonomic status of Chinese catfish of the family Cranoglanidae. *Proc. natn. Inst. Sci. India*, (B) **21** : 256-263.

JAYARAM, K. C. 1970. Contributions to the study of Bagrid fishes. 6. Skeleton of *Rita gogra* (Sykes)(Siluroidea : Bagridae). *J. zool. Soc. India*, **22** (2) : 117-146.

JOSEPH, N. I. 1960. Osteology of *Wallago attu*. *Proc. natn. Inst. Sci. India*, (B) **26** : 205-233.

KINDRED, J. E. 1919. The skull of *Ameiurus*. *Illinois biol. Monogr.*, **5** : 1-120.

KARANDIKAR, K. R. AND MASUREKAR, V. B. 1954. Weberian apparatus and other related structures of *Arius platystomus* Day. *J. Bombay Univ.*, **22** (5) : 1-28.

LENOUS, V. 1968. Morphology of the skull in *Tachysurus maculatus* (Thunberg). *Bull. Dep. mar. Biol. Oceanogr.*, **3** : 45-66, 11 figs.

MCMURRICH, J. P. 1884. The osteology of *Ameiurus catus* (L.). *Proc. Can. Inst.*, Toronto, new ser., **2** : 270-310.

MAHAJAN, C. L. 1966. A study in adaptation and natural relationship of *Sisor rabdophorus*. I. The head skeleton, *J. Zool. Lond.*, **149** : 365-393.

MAHAJAN, C. L. 1967. *Sisor rabdophorus*—A study in adaptation and natural relationship. 3. The vertebral column, median fins and their musculature. *J. Zool. Lond.*, **152** : 207-318, 15 figs.

MASUREKAR, V. B. 1962. Weberian apparatus in *Mystus gulio* (Ham. Buch.) and *Mystus bleekeri* (Day). *Proc. Indian Acad. Sci.*, (B) **55** (1) : 24-37.

NAIR, K. K. 1938. Changes in the internal structure of the air-bladder of *Eutropiichthys vacha* (Ham.). *Clupisoma garua* (Ham.) and *Ailia coila* (Ham.) during growth. *Rec. Indian Mus.*, **40** : 183-187.

NAWAR, G. 1954. On the anatomy of *Clarias lazera*. I. Osteology. *J. Morph.*, **94** : 551-585.

REICHEL, M. 1927. Etude anatomique du *Phreatobius cisternarum* Goeldi, silure aveugle du Bresil. *Revue suisse Zool.*, **34** (16) : 285-403.

SHELDEN, F. F. 1937. Osteology myology and probable evolution of the Nematognath pelvic girdle. *Ann. N. Y Acad. Sci.*, **37** (1) : 1-96.

SRINIVASACHAR, H.R.1957. Development of the skull in catfishes. II. Development of chondrocranium in *Mystus* and *Rita* (Bagridae). *Morph. Jb.*, **98** (2) : 224-262.

SRINIVASACHAR, H. R. 1958. Development of skull in catfishes. 5. Development of skull in *Heteropneustes fossilis* Bloch. *Proc. natn. Inst. Sci. India*, (B) **24** : 165-190.

SRINIVASACHAR, H. R. 1959. Development of the skull in catfishes, IV. The development of chondrocranium in *Arius jella* Day (Ariidae) and *Plotosus canius* (Plotosidae) with account of their inter-relationship. *Morph. Jb.*, **99** (4) : 986-1016.

SRINIVASACHAR, H. R. 1980. Evolution and Taxonomy of Catfishes of India. *Proc. Indian natn. Sci. Acad.*, (B) **46** (1) : 23-26.

TILAK, R. 1961. The osteocranium and the Weberian apparatus of *Eutropiichthys vacha* (Ham.) and *Eutropiichthys murius* (Ham.). A study of interrelationship. *Zool. Anz.*, **167** : 443-430.

TILAK R. 1963a. Studies on the Nematognathins pectoral girdle in relation to taxonomy. *Ann. Mag. nat. Hist.*, (13) **6** : 145-155.

TILAK, R. 1963b. The osteocranium and the Weberian apparatus of the fishes of the family Sisoridae (Siluroidea) : A study in adaptation and taxonomy. *Z. wiss. Zool.*, **168** : 281-320.

TILAK, R. 1963c. The osteocranium and the Weberian apparatus of a few representatives of the families Siluridae and Plotosidae (Siluroidea). A study of interrelationship. *Zool. Anz.*, **171** . 424-439.

TILAK, R. 1964. The osteocranium and the Weberian apparatus of the fishes of the family Schilbeidae (Pisces : Siluroidea). *Proc. zool. Soc. Lond.*, **143** (1) : 1-36.

TILAK, R. 1965a. The comparative morphology of the osteocranium and the Weberian apparatus of Tachysuridae (Pisces : Siluroidei). *J. Zool. Lond.*, **146** : 150-174.

TILAK, R. 1965b. The osteocranium and the Weberian apparatus of the fish of family Bagridae (Pisces : Siluroidei). *Morph. Jb.*, **107** : 415-443.

TILAK, R. 1966. The osteocranium and the Weberian apparatus of *Amblyceps mangois* (Hamilton) (Pisces : Siluroidei) in relation to taxonomy. *Zool. Anz.*, **174** : 61-74.

TILAK, R. 1967. Studies on the osteology of the Nematognathine girdle in relation to taxonomy. *J. zool. Soc. India*, **19** (1-2) : 101-110.